Characterization and Modeling of Fundamental Parameters of a Membrane-Aerated Biological Reactor

Completed Technology Project (2013 - 2017)

Project Introduction

Inherent in the expansion of human presence in space is the development of life support systems that are capable of meeting the demands of extended space habitation. Within these systems, water is the most critical life support element, representing, at minimum, 65% of the daily mass input for crew members. A reliable water source is therefore a critical item for long term space habitation, whether in orbit (e.g. ISS), on the moon, Mars or beyond. Water recycling systems allow the regeneration of potable water from waste streams, thus eliminating mission dependence on initial water reserves or resupply scenarios. However, current water recovery systems that employ only physical and chemical processes are intensive users of resources and ultimately result in trading the cost of stored water for the costs of power consumption and consumables. Membrane aerated biological reactors (MABRs) provide an attractive sustainable alternative due to the ability to maximize effluent quality, and recycle valuable components (e.g. H2O, N2). MABRs harness the benefits of biological treatment (transformation of organic matter and NH3 to CO2, NOx- and N2 gas, production of a more stable end waste product , and favorable pHs for further physio-chemical treatment) while also minimizing the impact on the habitation environment and decreasing the demand for inputs such as O2 by increasing removal efficiency. Much of the current research on MABRs provides results that are specific to the reactor configuration or the particular waste-stream loading. Current design and operation is at best semi-empirical as a number of interrelated fundamental processes including biological, physical, and chemical processes are not currently described sufficiently to allow the development of quantitative robust models. The proposed work will provide essential characterization of MABR systems and develop a quantitative understanding of the interdependence of gas flow, loading rate, biofilm microbial ecology, and membrane density in order to optimize the design and operation of MABRs. The successful completion of this objective would be the development of guiding principles based on the waste stream composition and desired treatment levels. Experimental data will be collected from a bench-scale reactors designed and operated at Texas Tech University. Additionally, data will be collected from the Counter-diffusion Membrane Aerated Nitrifying Denitrifying Reactor (CoMANDR) developed at Texas Tech University and scheduled for implementation as part of an integrated system test conducted at Johnson Space Center. The experimental data will be used to develop and validate theoretical models that can be used as predictive tools for operation and design of further MABR systems. The benefits of this research will not only apply to space based water reuse, but will also have numerous terrestrial applications thus continuing the legacy of space based technologies providing significant benefits to broader applications.

Anticipated Benefits

The successful completion of this objective would be the development of

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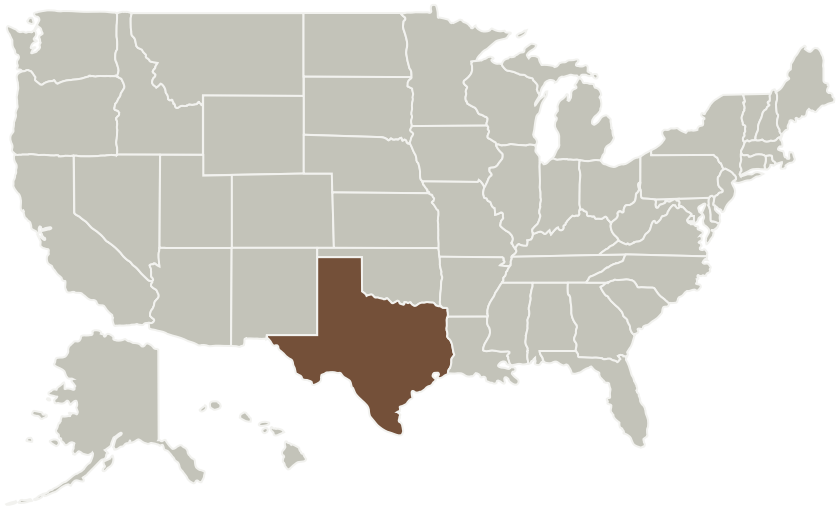
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Texas Tech University	Lead Organization	Academia	Lubbock, Texas

Primary U.S. Work Locations
Texas

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Texas Tech University

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Audra Morse

Co-Investigator:

Dylan Christenson

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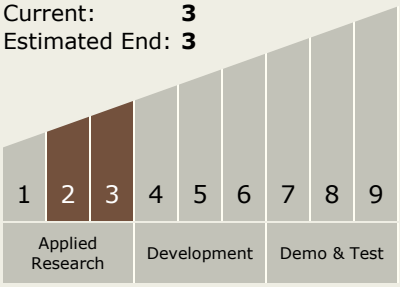
Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.1 Environmental Control & Life Support Systems (ECLSS) and Habitation Systems
    - TX06.1.5 ECLSS Modeling and Simulation Tools

Target Destinations

Earth, The Moon, Mars